Antecedents of Resilient Supply Chains: An Empirical Study

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Abstract: In recent years, there has been a proliferation of interest in resilience in the supply chain field. Even though literature has acknowledged the antecedents of resilient supply chains, such as supply chain visibility, cooperation, and information sharing, their confluence in creating resilient supply chains where other behavioural issues are prevailing (i.e. trust and behavioural uncertainty) has not been studied. To address this gap, we conceptualized a theoretical framework firmly grounded in the resource based view (RBV) and the relational view that is tested for 250 manufacturing firms using hierarchical moderated regression analysis. The study offers a nuanced understanding of supply chain resilience and implications of supply chain visibility, cooperation, trust and behavioural uncertainty. Implications and suggestions for further research are provided.

Index terms: ***Supply chain resilience, antecedents, resource based view, relational view.***

I. INTRODUCTION

The rapid expansion of global supply chains allows firm to derive competitive advantage through optimal allocation and exploitation of resources [1, 2]. However, global supply chains are also becoming more vulnerable to disasters, especially in the Asia–Pacific region [80] where natural disasters resulting from climate change are on the rise [50]. The recent damage and losses caused by these natural disasters for the region exceeded US$ 250 billion, accounting for more than two thirds of worldwide disaster losses [81]. In a supply-chain context, natural disaster risks include various phenomena such as earthquakes, floods and fires, which could impair business functions and decrease the productive capacity of firms operating in the affected region. Brandon-Jones et al. [6] point out that supply chain risk management, which remains as a key challenge, has generated significant interest among supply chain scholars. Hence, supply chain resilience has attracted the attention of both academics and practitioners, driven by the need of organizations to perform while resuming business continuity in periods of disruption [2, 3]. Literature has acknowledged visibility, cooperation, and information sharing as important antecedents of supply chain resilience [4, 5, 6, 7]. However, the confluence of these antecedents in creating resilient supply chains under interaction effect of behavioural uncertainty (BU) – defined as the inability to predict a partner behaviour or changes in the external environment– [8] has not been studied in-depth, giving us the impetus for this study. Therefore, our first research question is as follows: *What are the antecedents of resilient supply chains?* To answer this question, we draw on the resource-based view (RBV) and the relational view [8, 9]. We argue that visibility in supply chains is an important antecedent of risk reduction [6] and allows organizations to mitigate threats in their supply chain and safeguard organizational performance.

Literature has also argued for the role of contextual factors such as communication, integration and cooperation on enhancing resilience in supply chains [39, 66, 82]. The effectiveness of communication and cooperation may be enhanced or hampered due to BU factors [8, 85]. However, such crucial effects have not been addressed theoretically or subjected to empirical testing. Focusing on BU from a relational theory point of view [83, 84], we specify our second research question as follows: *What are the effects of behavioural uncertainty on the relationship between cooperation and resilience?* To answer this question we develop a theoretical model to help our understanding of how organizations can create resilient supply chains and we test the model empirically using cross-sectional data gathered with a survey based instrument. In doing so, we add to the understanding of the links between resources and capability, the relational constructs, and behavioural uncertainty, thus contributing to previous literature which has either utilized the RBV or relational view. To theoretically substantiate our test results, we integrate the two perspectives of the RBV and relational view, because neither perspective can, on its own, explain supply chain resilience [6, 10, 39]. From a management point of view, our results provide extensive guidance to the managers to understand how the interplay of resources, capability and relational constructs may help build supply chain resilience.

The rest of paper is organized as follows. In Section II, we synthesize the theoretical foundations of the study. In Section III, we illustrate our research framework and develop our hypotheses accordingly. In Section IV, we deal with the research methods, including operationalization of the constructs, sampling design, data collection and non-response bias. In Section V, we discuss our statistical analyses. In Section VI, we present the discussion of the results and the implications of the results to the theory and practice. Finally, in Section VII, we conclude with limitations and further research directions.

II. THEORY DEVELOPMENT

A. Resource based view

The RBV argues that an organization can achieve competitive advantage, exploit opportunities and/or mitigate threats by creating bundles of strategic resources and capabilities [9, 12, 20, 21, 22]. In the supply chain management field, the RBV has been used to study the achievement of competitive advantage through the supply chain based on the combination of valuable, rare, inimitable, and non-substitutable resources and capabilities [9, 20, 23, 24, 25]. Hitt and colleagues [25] have suggested that the contribution of RBV in the supply chain management field involves analysing supply chain activities individually and collectively [26] breaking down each of the activities in resources and capabilities to discuss how they are bundled together and how they can be integrated across the supply chain to contribute to both a focal firms' and the supply chain's competitive advantage. RBV has been used, for instance, to study supplier selection [27, 28] and the relationships between buyers and suppliers [29]. In a recent study, Brandon-Jones and colleagues [6] have argued that resources and capabilities have a positive impact on supply chain resilience and supply chain robustness. Hence, RBV is used as a basis of our theoretical model to discuss resilient supply chain.

B. Supply chain visibility

Visibility can be defined in different ways depending on the focus of the scholars on, for instance, information sharing or information characteristics (accuracy, timeliness, readiness, and speed of access) [42]. Hofstede [43] defines visibility as the "*extent to which all the actors along the supply chains have a shared understanding of, and access to, the product-related information that they request, without loss, noise, delay and distortion*" (p. 18). From an RBV perspective, supply chain visibility can be characterised as one of the desired capabilities in the supply chain (see [24]) which may reduce the negative impact of supply chain disruption [34].

Supply chain visibility can improve decision making, responsiveness, and operational and supply chain performance [34, 42, 44, 45]. Other scholars have underlined the importance of visibility for resilience [5, 16, 14, 46]. Blackhurst et al. [47] stressed the importance of supply chain visibility in avoiding and mitigating the effect of disruptions, whereas Jüttner and Maklan [14] suggested that making visible risks and knowledge across the supply chain improves resilience. Brandon-Jones et al. [6] argued that supply chain visibility further improves resilience and robustness in supply chain. They also argued that supply chain visibility is largely undefined and lacks consistent understanding among operations and supply chain management scholars. In this paper, we aim to contribute to this debate and argue that supply chain visibility is a mediating construct between information sharing, data connectivity and reduction in behavioural uncertainty which further enhances trust and commitment among supply chain partners to improve cooperation to achieve resilient supply chains.

C. Cooperation, trust, and behavioural uncertainty

Literature has discussed the role of relational competencies [30, 31, 32] in supply chain resilience. Scholars have underlined the importance of three types of relational competencies, that is, communication, cooperation, and integration [31, 32, 33]. These competencies help establish collaborative relationships across the supply chain to leverage supply chain resilience [34]. In this paper following [35] we argue that is important to discuss cooperation as a relational competency, which has often been neglected in the behavioural operations management literature [36, 37, 38]. Within cooperation, we focus on trust and commitment as important antecedents [39]. Trust is the willingness to take risk, whereas with commitment "*an exchange partner believing that an ongoing relationship with another is so important as to warrant maximum efforts at maintaining it; that is, the committed party believes the relationship endures indefinitely*" [35]. Welty and Becerra-Fernandez [40] argue that interplay between technology and trust can further enhance cooperation. Furthermore, Kwon and Suh [8] argue that the degree of information sharing among supply chain partners reduces behavioural uncertainty (BU) – namely "*the inability to predict a partner's behavior or changes in the external environment*" [41] – among partners, which further enhances trust, leads to commitment and builds cooperation among supply chain partners. Organizations "*create external linkages based on the sharing of information*" ([24], p. 1217). Reduction in BU can help organizations enhance trust and commitment among supply chain partners in their endeavour to gain competitive advantage [8].

D. Supply chain resilience

There is a rich body of literature on supply chain resilience [1, 4, 5, 11, 12, 13, 14, 15, 16, 17], but few formal definitions of supply chain resilience. Christopher and Peck [4] define supply chain resilience as "*the ability of a supply chain to return to normal operating performance, within an acceptable period, after being disturbed*". Ponomarov and Holcomb [13] define supply chain resilience as "*the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at desired levels of connectedness and control over structure and function*. Hence, Purvis et al. [1] argue that there is no consensus in the formal definition of the resilience. For instance, several other terms – such as agility, flexibility, risk, responsiveness, adaptability, alignment, robustness and redundancy – are linked with resilience [1]. Thus, following Brandon-Jones et al. [6] we define supply chain resilience as *the ability of the system to return to its original state, within an acceptable period, after being disturbed*. The definition is consistent with previous definitions [4, 11].

Academic literature has discussed different elements of supply chain resilience [4, 5, 11, 12, 13, 14, 15, 16, 17]. Christopher and Peck [4] defined four principles for supply chain resilience, namely supply chain reengineering, collaboration, agility, and supply chain risk management culture. Kamalahmadi and Parast [16], based on Christopher and Peck [4], have proposed the elements (variables) of flexibility, trust, information, sharing, visibility, leadership, and innovation that correspond to Christopher and Peck's principles of resilience. Hence, following recent scholarly debates see [18, 19], we propose a model that extrapolates the antecedents of resilience based on RBV and relational competencies. The theoretical underpinnings and elements of the model are discussed next.

III. THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

The foundation of our theoretical framework is inspired by RBV and the relational view [8, 9]. (Figure 1).

<< Insert Figure 1>>

A. Supply chain connectivity, information sharing and supply chain visibility

Following RBV we argue that bundling of resources, either tangible or intangible, leads to competitive advantage [51]. Zhu and Kraemer [51] argue that connectivity, which can be referred to as organizational IT infrastructure, is an important resource that can be exploited to build certain capabilities in supply chains [52] including supply chain visibility, which in turn can reduce inventory level and bullwhip effect [53]. Following Fawcett and colleagues [54] we can argue that supply chain connectivity may enhance supply chain visibility, however supply chain connectivity is dependent on the quality of information sharing. Brandon-Jones and colleagues [6] found that supply chain connectivity and information sharing both have positive impacts on supply chain visibility. Hence, we hypothesize:

H1: Supply chain connectivity has a positive impact on supply chain visibility.

H3: Information sharing has a positive impact on supply chain visibility.

Next following RBV, bundling 'supply chain connectivity' and 'information sharing' can improve supply chain visibility [6], a tangible resource [24]. Connectivity is an example of a technological resource that facilitates effective sharing of information [48]. On the other hand, information sharing may be categorized as organizational capital, a resource which focuses on flow of information [49]. Hence following [6] we can hypothesize:

H2: Supply chain connectivity has a positive impact on information sharing.

B. Trust and cooperation

In prior research, many scholars argue towards a positive relationship between trust and cooperation [8, 35, 57]. Morgan and Hunt [35] argue that trust is an important antecedent for cooperation among channel partners. Hence, in a similar vein we argue that the trust is an antecedent of cooperation among the partners in supply chain. Hence, we hypothesize it as:

H4: Trust has a positive impact on cooperation among members in the supply chain.

C. Supply chain visibility and supply chain resilience

Brandon-Jones and colleagues [6] argue for the positive relationship between supply chain visibility and supply chain resilience. Supply chain visibility can also reduce the probability and impact of a supply chain disruption and therefore lead to enhanced resilience [14, 34, 86] and the mitigation of supply chain risk [59], and the generation of common demand forecasts that, if combined with the proportional restoration rule, could further help to manage deviation in the observed inventory levels [60]. Hence, we hypothesize:

H5: Supply chain visibility has a positive impact on supply chain resilience.

D. Trust, cooperation and supply chain resilience

Morgan and Hunt [35] argue that cooperation is influenced directly by trust, whereas Scholten and Schilder [7] suggest that cooperation has a positive impact on supply chain agility and supply chain robustness, and subsequently supply chain resilience [4]. Literature also underlines the role of collaborative capabilities in sustainability commitment and performance [58] that facilitate supply chain resilience [39]. Trust and cooperation play a significant role in minimizing the effect of opportunistic behaviour which is an important ingredient for building resilient supply chain. Hence, we hypothesize:

H6: Trust has a positive impact on supply chain resilience.

H7: Cooperation has a positive impact on supply chain resilience.

E. Moderating effect of Behavioural Uncertainty

Cao and Zhang [63] argue that the uncertainty has often been viewed as a dominant contingency and may be one of the important determinants of high transaction costs. Reducing uncertainty via information sharing has attracted significant attention from O& SCM scholars. However, the majority of the studies have focused on reducing supply uncertainty, demand uncertainty and technological uncertainty through effective partnering. Cao and Zhang [63] argue that the intense communication among the supply chain partners may effectively reduce behavioural uncertainty, which is often cited as one the major determinants of poor trust and cooperation [85]. Park and Ungson [55] note that the degree of behavioural uncertainty among partners is the major source of tension in the strategic alliances. Krishnan and colleagues [56] argue that BU leads to a situation where it becomes difficult for an organization to anticipate and predict the actions of their partners. They suggest that BU has negative consequences on organizational performance, impacting negatively on trust. Hence, conversely, we can argue that a reduction in BU may improve the trust and cooperation among the partners in supply chain which may further improve the supply chain resilience [86]. Hence, we hypothesize as follows:

H8/H9: Reduction in behavioural uncertainty positively moderates the effect of trust and cooperation on supply chain resilience.

IV. METHODS

A. Measures

To test our hypothesized framework (see Figure 1), we derived testable research hypotheses (H1-H9). We used a survey method to test this theoretical model. The items tapping the theoretical constructs as shown in Figure 1 were developed based on an extensive review of literature (see Table 1). They were measured on a five-point Likert scale with anchors ranging from strongly disagree (1) to strongly agree (5) to ensure high statistical variability among survey responses.

The unit of analysis employed in this study was at the level of manufacturing plant and its major upstream supplier [6]. We selected manufacturing organizations following prior research (see [6, 62]) suggesting that manufacturing organizations provide a detailed understanding of how supply chain design affects performance.

Prior to data collection, we pre-tested the survey instrument with five senior managers and three academics who have published extensively and have strong research credentials in related areas for content validity. We asked the experts to critique the questionnaire for ambiguity, clarity, and appropriateness of the items used to operationalise each construct. A few changes were made based on the inputs of these experts to ensure high reliability and validity. All the exogenous constructs in the Figure 1 were operationalized as reflective constructs (see Table 1).

<< Insert Table 1>>

B. Data collection

The target sample was composed of managers included in the Indian Institute of Materials Management database. We selected 780 potential respondents by their job function (supply chain manager, materials management manager, logistics management manager or purchasing manager) (see Table 2) and the following industry codes (NIC) reflecting manufacturing organizations:

16 "manufacture of wood and products of wood and cork, except furniture...";

17 "manufacture of paper and paper products";

19 "manufacture of coke [solid fuel] *and refined petroleum products"*;

20 "manufacture of chemicals and chemical products";

22 "manufacture of rubber and plastic products";

25 "manufacture of fabricated metal products, except machinery and equipment".

We e-mailed the questionnaires to the respondents. Each questionnaire included a cover letter in which the purpose of the study was explained, following Dillman's total-test design method (see [65]). After five weeks, we had received 120 usable responses. We sent further reminders via e-mail and followed up by phone. After another four weeks, we had received a further 130 usable responses. Hence, we received a total of 250 usable responses, which represents 32.05% (250/780 = 32.05%). In comparison to prior survey based studies (see [64, 66], our sample size is sufficient for a hypothesis test.

Before we proceeded to data analysis, we undertook a non-response bias test. Following [67], we compared the responses of early and late waves of returned surveys based on the assumption that the opinions of the late respondents are representative of the opinions of the non-respondents (see [67]). The t-tests yielded no statistically significant differences ($p=0.76$) between early-wave (120 responses) and late-wave (130 responses), suggesting that non-response bias was not a problem. The final sample consisted of 30 directors (12%), 75 vice-presidents (30%) and 145 general managers (58%). The respondents primarily worked for medium to large firms with 32% of the respondents working for large firms with more than 1,000 employees and a gross income of more than US $150 million.

<< Insert Table 2>>

V. DATA ANALYSES AND RESULTS

It is suggested by prior research to examine for assumption of constant variance, existence of outliers, and normality before checking for reliability and validity of the constructs (see [66, 68, 69]). We used plots of residuals by predicted values and statistics of skewness and kurtosis. To detect multivariate outliers, we used Mahalanobis distances of predicted variables [66, 68]. The maximum absolute values of skewness and kurtosis of the measures in the remaining dataset were found to be 1.66 and 2.07 respectively. These values are well within the limits recommended by past research (univariates skewness<2, kurtosis<7) ([70]). We did not find any plots nor did the statistics indicate any significant deviances from the assumption.

A. Measurement validation

We used a three-stage process (see [69]) to develop measures that satisfied all the requirements for reliability, validity, and unidimensionality. To evaluate reliability, we used the average correlation among items in a scale [71]. We can see from Table 3 that the Cronbach's α (alpha) value for each construct is well above the accepted cut-off of 0.7 [72].

Next, we assessed two types of validity: convergent and discriminant [73]. As shown in Table 3, items load on the intended constructs with standardized loadings greater than 0.5, the scale composite reliability (SCR) greater than 0.7 and the average variance extracted (AVE) greater than 0.5. Hence, we can argue that there is sufficient evidence for convergent validity. Fawcett and colleagues [73] noted that for discriminant validity, all the items should have higher loadings on their assigned constructs than on any other constructs. Furthermore, the mean shared variance should be below 0.50. Alternatively, the square root of the AVE for each construct should be greater than any correlation estimate (see Table 4). Hence, we can argue that there is sufficient evidence for discriminant validity.

<< Table 3>>

<<Table 4>>

Finally, we assessed the unidimensionality of our theoretical framework constructs via the following two conditions [74]. Firstly, an item must be significantly associated with the empirical indicators of the construct and secondly, it must be associated with one and only one construct [69]. To test for unidimensionality we tested the overall fit of our model. Based on the literature [69, 75, 76], multiple fit criteria were utilized to assess model fit (see Appendix A). Hence based on Appendix A we can conclude that constructs exhibit unidimensionality.

B. Common method bias

In the case of self-reported data, there is a high possibility of common method biases resulting from multiple sources such as consistency motif, implicit theories, social desirability, leniency biases and acquiescence biases. We attempted to enforce a procedural remedy by asking respondents not to estimate supply chain resilience based on their own experience, but to obtain this information from minutes of organizational meetings or from documentation [77]. Furthermore, we performed statistical analyses to assess the severity of common method bias. We conducted the Harman's one-factor test following the suggestions of [77] on seven variables in our theoretical model. The results showed that the seven factors are present and the most covariance explained by any one factor was 40.48% (see Appendix B), indicating that common method bias is not likely to contaminate our results.

C. Hypothesis testing

We tested our research hypotheses following [61, 66] and Brandon-Jones et al. [6]. According to Eckstein et al. [66] hierarchical regression analysis is considered the most appropriate and a more conservative technique than covariance-based modelling approaches, due to the complexity of the model and the available data points, and the great robustness of the technique. The hypotheses (H1-H7) were tested using hierarchical regression analysis as shown in Table 5. The results suggest that H1 (β=0.376; p=0.000), H2 (β=0.569; p=0.000) and H3 (β=0.411; p=0.000) are supported, consistent with [6]. The control variable organization size does not have any significant effect on the model (see Table 5). We interpret that organization size (OS) has little role to play on the impact of supply chain connectivity on information sharing and supply chain visibility. H4 is supported (β=0.722; p=0.000) which is found to be consistent with [8, 35]. H5 is supported (β=0.110; p=0.007) which is found to be consistent with [6]. H6 is supported (β=0.727; p=0.000) and H7 is supported (β=0.307; p=0.000) which is found to be in consistent with [39].

<<Insert Table 5>>

H8 and H9 were tested using hierarchical multiple moderated regression. Step 1 of Table 6 shows that organization size has no significant effect on supply chain resilience (β=0.062; p=0.015). Step 2 includes the direct effect of trust and cooperation as well as the direct effect of moderator variable (BU). Table 6 indicates that trust (β=0.870; p=0.000) and cooperation (β=0.698; p=0.000), supporting previous findings of Wieland and Wallenburg [39]. The model also indicates that the reduction in BU has direct influence on supply chain resilience (β=0.599; p=0.000). This finding of ours further support previous qualitative findings of Jüttner and Maklan [86]. The results show that reduction in behavioural uncertainty among the partners will help to create more resilient supply chains. Although scarce theoretical rationale has been developed yet in the literature, these exploratory tests motivate future studies that would shape the future research related to the differential effects of reduction in behavioural uncertainty on supply chain resilience in different contexts. Step 3 adds the interaction effects to our model. In support of hypothesis H8 and H9, the full model indicates that behavioural uncertainty has a significant interaction effect, where the impact of trust (β=0.116; p=0.000) and cooperation (β=0.113; p=0.000) on supply chain resilience are stronger for a higher level of the reduction of behavioural uncertainty.

<< Insert Table 6>>

VI. DISCUSSION

A. Theoretical Implications

In this paper we drew on RBV suggesting that the bundling of resources and capabilities can be utilized to create competitive advantage [9, 20]. We considered supply chain connectivity and information sharing as complementary resources which may be bundled together to create supply chain visibility as a capability [6, 21]. Following [6] we hypothesized that both supply chain connectivity and information sharing can create supply chain visibility and that supply chain visibility may be exploited to expose sources of the supply chain risk and to exploit opportunities, if any [6, 21]. Wieland and Wallenburg [39] argue that cooperation among the supply chain partners enhances supply chain resilience. We argue based on [85] that reduction in behavioural uncertainty may enhance the direct effects of trust and cooperation on supply chain resilience. Building upon [39], we investigated how reduction of BU can further influence trust and cooperation. By adopting RBV logic [6] and relational view [39], we have attempted to provide better insight into supply chain resilience.

Our contribution is threefold. Firstly, we demonstrate that behavioural dimensions have a significant impact on resilience along with other important resources of the firm. Secondly, we have shown empirically that reduction in behavioural uncertainty has a positive interaction effect on trust and cooperation. These results extend [6, 39] which do not consider the role of reduction in uncertainty among supply chain partners on direct effects of trust and cooperation on resilience. Finally, we have shown that our integrated model explains 68.4 % of the total variance (R^2) in supply chain resilience. If we compare our model R^2 with the existing models, then the explanatory power of our model is comparatively high. Hence, we can argue that trust, cooperation among supply chain partners and supply chain visibility may help to build resilient supply chains.

B. Managerial implications

Our results provide some useful implications for supply chain managers who face a constant dilemma: invest in appropriate technology or to wait. Hence, we enumerate three implications. Firstly, investing in appropriate technology and quality information sharing may help to improve supply chain visibility. Secondly, by reducing behavioural uncertainty an organization may achieve better interplay of trust and cooperation among the partners to build a more resilient supply chain. Thirdly, by proper integration of supply chain visibility, trust and cooperation, supply chain resilience can be significantly improved. Hill [87] argued that in the long run, the invisible hand of the market favours those organizations whose behavioural repertoires support trust and cooperation rather than competition and opportunism. Such behavioural repertoires enable partners to work together to mitigate the risk resulting from disasters: man-made or natural. Thus, managers need to focus on collaborative relationships, instead of cultivating competition and opportunism. We recognize that providing recommendations based on data gathered from manufacturing organizations may be a limitation as, for instance, service organizations have their own challenges. The study has only addressed companies in the Indian manufacturing context. However, it should be noted that our studies are based on those organizations that have already invested in technology and information sharing to create visibility across the supply chain. Thus, the study findings should be applied to other contexts with caution.

C. Limitations and future research directions

In this section, we deal with our limitations and unanswered questions. We have adopted RBV but have only considered supply chain connectivity and information sharing as tangible and intangible resources. Other resources such as human skills (i.e. managerial skills and technical skills) and learning culture may have significant effects on supply chain visibility as a desired capability of the organization.

The methods we have used to investigate supply chain visibility could be applied to the exploration of other organizational capabilities such as supply chain agility, adaptability and alignment. We admit that using the survey based approach [79] we could not measure the complexity associated with behavioural uncertainty. However, qualitative research methods may answer some of these unanswered questions.

Finally, in this paper we have considered resilience. However, other concepts such redundancy, robustness and rapidity are also considered to be important characteristics of supply chain resilience. Hence, a simulation-based modelling approach could further help quantify these aspects.

VII. CONCLUSION

Drawing broadly on RBV and the relational view, we argue that resources, capabilities, behavioural uncertainty, trust, commitment and cooperation are the predictors of supply chain resilience. Our theoretical framework reconciles the independent contributions of two well established streams in the literature: bundling of resources and capabilities and impact of behavioural uncertainty-trust-cooperation. We attempt to explain the interaction effect of reduction of behavioural uncertainty on the path connecting trust and supply chain resilience and cooperation and supply chain resilience. Analysis based on 250 Indian manufacturing organizations supports the hypothesized relationships in the framework.

This research makes a significant contribution to supply chain resilience literature by focusing on much neglected behavioural dimensions. It confirms that supply chain visibility, trust and cooperation influence resilience significantly. We believe that we provide to researchers and practitioners food for thought to study further the role of resources and capabilities, as well as of behavioural uncertainty on visibility and supply chain resilience.

Table 1: Operationalization of Constructs

Construct	Measures	Literature
Supply chain connectivity (SC)	SC1: Current information systems meet the supply chain communications requirements. SC2: Information applications are highly integrated within firm and supply chain. SC3: Adequate information linkages exist with supply chain partners.	[6, 54]
Information sharing (IS)	IS1: Our firm exchanges relevant information with our partner. IS2: Our firm exchanges timely information with our partner. IS3: Our firm exchanges accurate information with our partner. IS4: Our firm exchanges complete information with our partner. IS5: Our firm exchanges confidential information with our partner.	[6, 63]
Supply chain visibility (SCV)	SCV1: Inventory levels are visible throughout the supply chain. SCV2: Demand levels are visible throughout the supply chain.	[64]
Behavioural uncertainty (BU)	BU1: We can accurately predict the performance of our partner for our next business cycle. BU2: We know that our partner will adapt quickly, should we change our specifications at short notice. BU3: We can predict changes in the pricing of our partner's products/services for the next year. BU4: We can predict the introduction of our partner's new product/services.	[6, 57]
Trust (T)	T1: Even when our partner gives us rather unlikely explanations, we are confident that he's telling the truth. T2: Our partner has often provided us with information that has later proved to be accurate. T3: Our partner usually keeps the promises that he makes to the firm. T4: Whenever our partner gives us advice on our business operation we know that he's sharing his best judgement. T5: Our organization can count on our partner to be sincere.	[57]

	T6: Though circumstances change, we believe that our partner will be ready and willing to aid and support. T7: When making important decisions, our partner is concerned about our welfare. T8: When we share our problems with our partner, we know that he will respond with understanding. T9: In future, we can count on our partner to consider how its decisions and action will affect us. T10: When it comes to things that are important to us, we can depend on our partner's support.	
Cooperation (CO)	CO1: No matter who is at fault, problems are joint responsibilities. CO2: One party will not take unfair advantage of strong bargaining position. CO3: We are willing to make cooperative changes. CO4: We do not mind owing each other favour.	[39]
Supply chain resilience (SCR)	SCR1: Material flow would be quickly restored. SCR2: It would not take long time to recover to normal operating performance. SCR3: The supply chain would easily recover to its original state. SCR4: Supply chain disruptions would be dealt with quickly.	[6]
Organization size (OS)	OS1: Number of employees. OS2: Revenue.	[61]

Table 2: Sample Profile (N=250)

Industry Code (NIC)	Count	Percent
16 (Wood and products of wood)	12	4.8
17 (Manufacture of paper and paper products)	18	7.2
19 (Manufacture of coke and refined petroleum products)	22	8.8
20 (Manufacture of chemicals and chemical products)	53	21.2
22 (Manufacture of rubber and rubber products)	78	31.2
25 (Manufacture of fabricated metal products, except machinery and equipment)	67	26.8
Number of employees		
Less than 100	35	14
101-500	63	25.2
501-1000	72	28.8
1000 or more	80	32
Annual Sales ($)		
150 million and above	67	26.8
more than 100 million and less than 150 million	130	52
Less than 100 million	53	21.2
Position of the respondent		
Director	30	12
Vice-President	75	30
General Manager	145	58

Table 3: Convergent Validity

Construct	Indicators	λi	Variance	Error	SCR	AVE
Supply chain connectivity (α=0.96)	SC1	0.60	0.36	0.64	0.83	0.63
	SC2	0.89	0.79	0.21		
	SC3	0.85	0.72	0.28		
Information sharing (α=0.95)	IS1	0.67	0.45	0.55	0.85	0.53
	IS2	0.67	0.45	0.55		
	IS3	0.83	0.68	0.32		
	IS4	0.84	0.70	0.30		
	IS5	0.59	0.35	0.65		
Supply chain visibility (α=0.95)	SCV1	0.87	0.75	0.25	0.86	0.75
	SCV2	0.87	0.75	0.25		
Behavioral uncertainty (α=0.95)	BU1	0.64	0.41	0.59	0.89	0.67
	BU2	0.91	0.82	0.18		
	BU3	0.83	0.69	0.31		
	BU4	0.86	0.74	0.26		
Trust (α=0.95)	T1	0.73	0.53	0.47	0.92	0.53
	T2	0.70	0.48	0.52		
	T3	0.59	0.34	0.66		
	T4	0.81	0.66	0.34		
	T5	0.87	0.75	0.25		
	T6	0.79	0.63	0.37		
	T7	0.71	0.51	0.49		
	T8	0.80	0.64	0.36		
	T9	0.55	0.30	0.70		
	T10	0.64	0.41	0.59		
Cooperation (α=0.95)	CO1	0.89	0.80	0.20	0.86	0.61
	CO2	0.80	0.64	0.36		
	CO3	0.64	0.41	0.59		
	CO4	0.76	0.58	0.42		
Supply chain resilience (α=0.95)	SCR1	0.80	0.63	0.37	0.86	0.62
	SCR2	0.79	0.62	0.38		
	SCR3	0.85	0.73	0.27		
	SCR4	0.70	0.48	0.52		

Table 4: Intercorrelation Matrix

	SC	IS	SCV	BU	T	CO	SCR
SC	**0.79**						
IS	0.34	**0.73**					
SCV	0.55	0.26	**0.87**				
BU	0.59	0.29	0.50	**0.82**			
T	0.59	0.32	0.48	0.42	**0.73**		
CO	0.30	0.08	0.31	0.26	0.29	**0.78**	
SCR	0.42	0.30	0.29	0.23	0.32	0.29	**0.79**

Table 5: Hierarchical Multiple Regression Results for Supply Chain Visibility, Information Sharing, Trust and Cooperation for H1-H7

Variables	DV=IS		DV=SCV		DV=CO		DV=SCR	
	β	p	β	p	β	p	β	p
Controls								
OS	0.219	0.322	0.219	0.322				
Main effects								
SCV							0.110	0.007
SCC	0.569	0.000	0.376	0.000				
IS			0.411	0.000				
T					0.722	0.000	0.727	0.000
CO							0.307	0.000
Model summary								
R^2	0.386		0.246		0.464		0.678	
Adj R^2	0.381		0.237		0.459		0.673	
Model F	77.578		26.795		106.797		129.254	

Table 6: Hierarchical Moderated Regression Results for (H8-H9)

Variables	Control Model		Main Effects Model		Full Model	
	β	p	β	p	β	p
Controls						
OS	0.029	0.910	0.029	0.910	0.062	0.015
Main effects						
T			0.797	0.000	0.870	0.000
CO			0.678	0.000	0.698	0.000
BU			0.739	0.000	0.599	0.000
Interaction effects						
T* BU					0.116	0.000
CO*BU					0.113	0.000
Model summary						
R^2	0.000		0.678		0.684	
Adj R^2	0.000		0.673		0.676	
Model F	0.013		129.024		87.625	
ΔR^2			0.673		0.006	
ΔF			129.011		-41.386	

Appendix A: Unidimensionality Test (Fit indices and their acceptable limits)

Absolute fit index	Acceptable threshold levels	Our observed values	Description
Relative (κ^2/df)	2:1 [78] 3:1 [79]	1.56	This value adjusts for sample size.
CFI (Comparative fit index)	Values should be greater than 0.98	0.98	
GFI (goodness of fit)	Values should be greater than 0.95	0.97	The GFI values lies between 0 to 1, with higher values reflecting better model fit
AGFI (Adjusted goodness of fit)		0.95	
RMSEA (Root mean square error of approximation)	Values less than 0.07 [80]	0.05	Represent that sample has known distribution. Favours parsimony.
NFI (Normed fit index)	Values greater than 0.95	0.96	Assesses fit relative to baseline model which assumes no covariance between the observed variables.

Appendix B: Common Method Bias

Components	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.95	40.48	40.48	12.95	40.48	40.48
2	2.52	7.86	48.35			
3	1.74	5.45	53.80			
4	1.60	5.01	58.81			
5	1.32	4.14	62.94			
6	1.19	3.73	66.67			
7	1.10	3.45	70.12			
8	1.10	3.42	73.55			
9	0.98	3.05	76.60			
10	0.88	2.75	79.35			
11	0.79	2.48	81.83			
12	0.69	2.14	83.98			
13	0.60	1.89	85.86			
14	0.58	1.82	87.68			
15	0.54	1.68	89.35			
16	0.45	1.39	90.75			
17	0.40	1.26	92.00			
18	0.36	1.12	93.13			
19	0.33	1.02	94.15			
20	0.28	0.88	95.02			
21	0.25	0.79	95.81			
22	0.23	0.71	96.51			
23	0.18	0.58	97.09			
24	0.17	0.53	97.62			
25	0.16	0.49	98.11			
26	0.13	0.42	98.53			
27	0.12	0.37	98.90			
28	0.10	0.30	99.20			
29	0.09	0.27	99.47			
30	0.07	0.22	99.69			
31	0.06	0.17	99.86			
32	0.04	0.14	100.00			

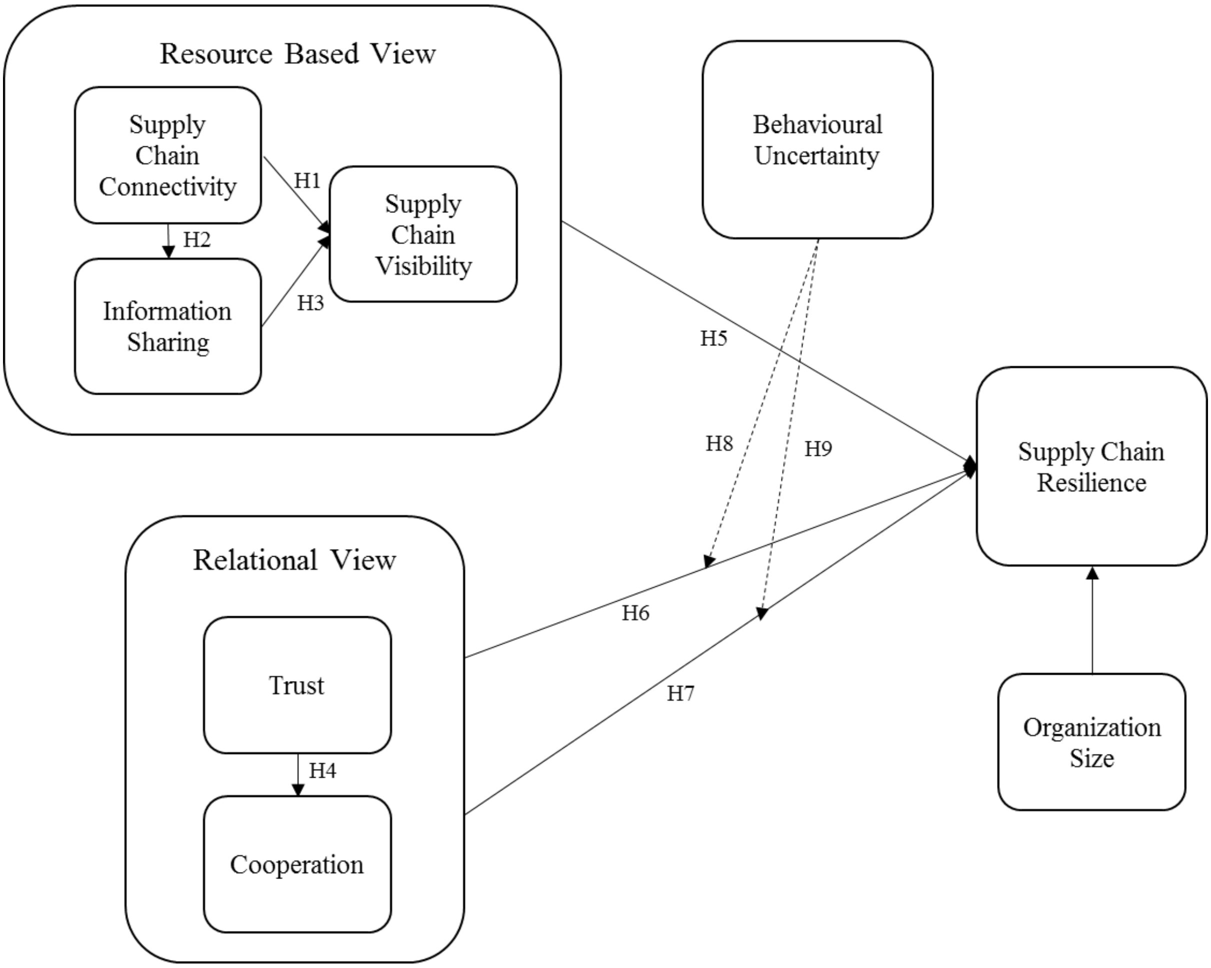

Figure 1: Theoretical Framework

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